REMARKS

In view of the above amendments and following remarks, reconsideration and further examination are requested.

Initially, the Examiner is respectfully requested to acknowledge Applicants' claim for Foreign Priority submitted August 29, 2001.

The specification and abstract have been reviewed and revised to make editorial changes thereto and generally improve the form thereof, and a substitute specification and abstract are provided. No new matter has been added by the substitute specification and abstract.

By the current Amendment, claims 1-10 have been cancelled and claims 11-35 have been added. New claims 11-35 have been drafted taking into account the 35 U.S.C. § 112, second paragraph, concerns expressed by the Examiner, are believed to be free of these concerns, and are otherwise believed to be in compliance with 35 U.S.C. § 112, second paragraph.

The instant invention pertains to a method for assembling an integral electronic device, and the integral electronic device assembled by the method.

With reference to Figures 1-5, for example, the method comprises holding an electronic component 103 in an opening 102 that extends completely through a thickness of a first board 101, and then electrically connecting a second board 105 to the electronic component so as to provide an integral electronic device including the first board, the electronic component and the second board. Claim 11 is believed to be representative of this method, and claim 24 is believed to be representative of the integral electronic device assembled by performing this method.

The Examiner rejected claims 1 and 3-6 under 35 U.S.C. § 102(e) as being anticipated by Bertin et al. The Examiner rejected claims 1 and 3-5 under 35 U.S.C. § 102(a) as being anticipated by Kelkar et al. The Examiner rejected claims 7-10 under 35 U.S.C. § 103(a) as being unpatentable over Bertin et al. in view of Kuczynski. The Examiner rejected claims 7-9 under 35 U.S.C. § 103(a) as being unpatentable over Kelkar et al. in view Kuczynski. And, the Examiner rejected claim 2 under 35 U.S.C. § 103(a) as being unpatentable over Kelkar et al. in view of Brofman et al. These rejections are respectfully traversed in part, and the references relied upon by the Examiner are not applicable with regard to the newly added claims for the following reasons.

New independent claim 11 recites a method for assembling an integral electronic device, comprising

> in an opening that extends completely through a thickness of a first board, holding an electronic component... and electrically connecting a second board to said electronic component...

Similarly, independent claim 24 recites an integral electronic device that comprises

> a first board having an opening that extends completely through a thickness of said first board... an electronic component held within said opening... and a second board electrically connected to said electronic component.

Such a method for assembling an integral electronic device, and such an integral electronic device are not taught or suggested by any of the references relied upon by the Examiner.

In this regard, while Bertin et al. does disclose an electronic component 148 held within an opening 144 of a first board 142 with a second board 140 electrically connected to the electronic component, and while Kelkar et al. does disclose an electronic component 306 held within an opening of a first board 302 with a second board 316 electrically attached to the electronic component, in each of Bertin et al. and Kelkar et al. the corresponding opening does not extend "completely through" the first board. Accordingly, neither independent claim 11 nor independent claim 24 are anticipated by either one of Bertin et al. and Kelkar et al. Additionally, there would have been no motivation to have the openings of Bertin et al. and Kelkar et al. extend completely through their corresponding first boards. Thus, claims 11 and 24 are allowable over each of these references taken alone.

Kuczynski and Brofman et al. fail to resolve the above deficiencies of Kelkar et al. and Bertin et al., and accordingly, claims 11 and 24 are also allowable over any combination of these four references. Thus, claims 11-35 are allowable.

Additionally, certain of the dependent claims are believed to be patentable in their own right. In this regard, new claims 21 and 33 require that the electronic component is held

> (with)in said opening via an insulating resin that surrounds said electronic component except for upper and lower surfaces of said electronic component.

Such a feature is not taught or suggested by any of the references relied upon by the Examiner. Thus, claims 21 and 33 are each patentable in its own right.

Additionally, each of claims 22 and 34 is believed to be patentable in its own right because each of these claims requires a third board that is electrically connected to the lower surface of the electronic component. Such a feature is not taught or suggested by any of the references relied upon by the Examiner, and accordingly, claims 22 and 34 are each patentable in its own right.

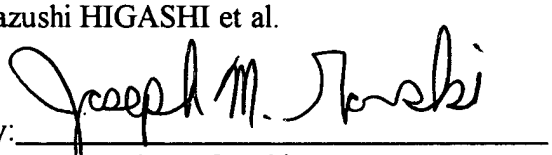
And, each of claims 23 and 35 requires that the first board has at least two openings that extend therethrough, with these openings being parallel to one another. Such parallel openings are not taught or suggested by any of the references relied upon by the Examiner, and accordingly, each of claims 23 and 35 is patentable in its own right.

In view of the above amendments and remarks, it is respectfully submitted that the present application is in condition for allowance and an early Notice of Allowance is earnestly solicited.

If after reviewing this Amendment, the Examiner believes that any issues remain which must be resolved before the application can be passed to issue, the Examiner is invited to contact the Applicants' undersigned representative by telephone to resolve such issues.

Respectfully submitted,

Kazushi HIGASHI et al.

By: 

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METHOD FOR ASSEMBLING INTEGRAL TYPE ELECTRONIC ~~COMPONENT~~ DEVICE, AND INTEGRAL TYPE ELECTRONIC ~~COMPONENT~~ DEVICE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a method for assembling an integral type electronic ~~component~~ device which is manufactured by combining a plurality of electronic components in one body, and an integral type electronic ~~component~~ device assembled by the method.

[0002] In response to ~~the~~ recent advancement of making electronic ~~components~~ devices small and light-weight, there has been proposed a large number of ways to further miniaturize ~~the~~ electronic ~~components~~ devices. Many of ~~the~~ electronic ~~components~~ devices manufactured by the proposed ways are formed by combining an electronic component having two or more functions with a device having one function.

[0003] Various mounting processes and facilities have been developed hitherto to arrange ~~the~~ electronic components highly accurately with high reliability. A conventional method of assembling ~~the~~ electronic components will be described below with reference to Figs. 8-11.

[0004] ~~In the first place~~ Initially, conductive adhesive 2 ~~are~~ is supplied onto a board 1 as shown in Fig. 8. Then, electronic components 3 are placed ~~to parts~~ on portions of the conductive adhesive 2 as shown in Fig. 9 and fixed to the conductive adhesive 2 with hardening of the conductive adhesive 2. After conductive adhesive 4 ~~are~~ is supplied onto the electronic components 3 as shown in Fig. 10, a board 5 is placed on the conductive adhesive 4 as shown in Fig. 11. The conductive adhesive 4 ~~are~~ is then hardened ~~last~~, whereby an integral type electronic component 6 is formed.

[0005] ~~In~~ With the conventional ~~arrangement of the above-described manner~~ method as described above, ~~the method requires~~ mounting of each of the components onto the board 1 is required, and therefore, the method is not ~~fit~~ suitable for devices requiring a mounting accuracy, for example, ~~in~~ for mounting optical components necessitating an optical path alignment, ~~etc.~~ and the like. The electronic components 3 undesirably vary in height from the board 1 because the electronic components 3 are placed on the conductive adhesive 2. As a result, when the board 5 is mounted onto the electronic components 3 ~~in the next process~~ during a subsequent step, ~~the~~ a so-called open fault, in which ~~that~~ the electronic components 3 and the board 5 are not electrically connected with

each other, possibly arises. Further, in ~~the~~ a case where there are many electronic components 3 to be mounted, it takes a long time before all the components 3 are mounted completely, and also there are problems in that a quality of mounting of the components on the conductive adhesive 2 deteriorates and a cost increases because of a long manufacturing time.

SUMMARY OF THE INVENTION

[0006] The present invention is devised to solve the above problems and has for its object to provide an easy, high-quality and low-cost method for assembling an integral type electronic ~~component~~ device, and an integral type electronic ~~component~~ device assembled by the method.

[0007] In order to accomplish the above and other ~~aspects~~ objects, there is provided a method for assembling an integral type electronic ~~component~~ device according to a first aspect of the present invention, which comprises:

storing and holding an electronic component ~~to~~ in a component storage part (opening) of a first board; and

electrically connecting a second board to the electronic component stored and held ~~to~~ in the component storage part of the first board, thereby forming ~~the~~ an integral type electronic ~~component of~~ device including the first board and the second board.

[0008] Bumps of the second board may be flattened before the second board is electrically connected to the electronic component after the electronic component is stored and held ~~to~~ in the component storage part of the first board.

[0009] An integral type electronic ~~component~~ device is provided according to a second aspect of the present invention, which comprises:

a first board with a component storage part (opening) for storing and holding an electronic component; and

a second board which is electrically connected to the electronic component stored and held ~~to~~ in the component storage part of the first board, thereby being united with the first board.

[0010] In the second aspect, when the electronic component is a light-emitting element, the component storage part may be formed to have a side wall for shielding light of the light-emitting element.

[0011] In the second aspect, the first board can be formed of any one of glass, ceramic and an organic resin.

[0012] In the second aspect, the electronic component may be held ~~to~~ in the component storage part with a photo-curing type insulating resin.

[0013] According to the assembling method for the integral type electronic ~~component~~ device of the first aspect of the present invention, and the integral type electronic ~~component~~ device of the second aspect, the second board is electrically connected to ~~the~~ electronic components after the electronic components are stored and held ~~to the~~ in component storage parts (openings) of the first board. Therefore, ~~the~~ an arrangement accuracy of the electronic components is determined on ~~the~~ a basis of ~~the~~ an arrangement accuracy of the component storage parts ~~formed to~~ of the first board. Also, the electronic components stored and held in the component storage parts are restricted in motion. Furthermore, since it is ~~enough~~ sufficiently simple to insert the electronic components ~~to~~ in the component storage parts, a long time is not required to ~~finish the~~ complete mounting as compared with the conventional art, even if a lot of electronic components are to be mounted. ~~The manufacturing~~ Manufacturing time is shortened and costs can be reduced in comparison with the conventional art.

[0014] The electronic components can be arranged highly accurately and simply at low costs in comparison with the conventional art.

[0015] The so-called open fault can be avoided by flattening ~~the~~ bumps of the second board.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] These and other aspects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

[0017] Fig. 1 is a sectional view of a first board ~~among diagrams showing each of states of board and the like~~ which is ~~obtained by~~ used for carrying out a method for assembling an integral type electronic ~~component~~ device, according to an embodiment of the present invention;

[0018] Fig. 2 is a sectional view of the first board indicating a state with electronic components filled in component storage parts of the first board ~~shown in Fig. 1~~;

[0019] Fig. 3 is a sectional view of the first board indicating a state in which electronic components filled in the first board ~~of Fig. 1~~ are fixed with an adhesive;

[0020] Fig. 4 is a side view of a second board to be fitted to the first board ~~of Fig. 1~~;

[0021] Fig. 5 is a diagram showing a state in which the first board ~~of Fig. 3~~ , having electronic components fixed with the adhesive, and the second board ~~of Fig. 4~~ are joined;

[0022] Fig. 6 is a diagram of a state in which a third board is joined to ~~the board~~ a product obtained by joining the first board ~~and~~ to the second board;

[0023] Fig. 7 is a flow chart explanatory of the method for assembling an integral type electronic ~~component in~~ device according to the embodiment of the present invention;

[0024] Fig. 8 is a diagram showing a state with a conductive adhesive supplied to a board, ~~among diagrams showing each of states of board and the like~~ which is ~~obtained by~~ used for carrying out a conventional method for assembling an integral type electronic ~~component~~ device;

[0025] Fig. 9 is a diagram of a state with components mounted to the conductive adhesive ~~of Fig. 8~~;

[0026] Fig. 10 is a diagram of a state with a conductive adhesive supplied to upper parts of the components ~~of Fig. 9~~; and

[0027] Fig. 11 is a diagram of a state with a board mounted to an upper part of the conductive adhesive ~~of Fig. 10~~ supplied to the upper parts of the components.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] A method for assembling an integral type electronic ~~component~~ device, and an integral type electronic ~~component~~ device assembled by the integral type electronic component assembling method, which are embodiments of the present invention will be described below with reference to the drawings. Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals.

[0029] The integral type electronic component assembling method is carried out in a manner as will be discussed below.

[0030] In a step ~~(designated by "S" in Fig. 7) 1~~ S1 of Fig. 7, component storage parts (openings)102 are formed by dry etching or wet etching ~~to~~ a first board 101 as shown in Fig. 1. Each of the component storage parts 102 is a recessed part in which an electronic component 103 to be described below can be stored. Each component storage part may be a bottomed shape or can be, e.g., a through hole penetrating in a thickness direction of the first board 101 as indicated in Fig. 1. Although a plurality of the component storage parts 102 are formed ~~to~~ in the first board 101 in Fig. 1, there may be formed one storage part from a relationship with ~~the~~ an electronic component 103 to be stored. The component storage part 102 is necessary to be larger by, for instance, 5-30μm than the electronic component 103 to be stored. For example, an Si substrate, a glass substrate, a ceramic substrate, an organic resin material substrate or the like is used as the first board 101. The storage parts 102 are parallel to each other such that when plural electronic components 103 are received within plural component storage parts, the electronic components are also parallel to each other.

[0031] A crystal orientation of Si may be any of (1,1,1), (1,0,0) and (1,1,0) when ~~the~~ an Si substrate is used.

[0032] In a next step ~~2~~ S2, as shown in Fig. 2, ~~the~~ electronic components 103 are disposed ~~to~~ within the component storage parts 102. ~~The~~ Each electronic component 103 corresponds to, for example, a light-emitting element such as an LED (light-emitting diode) or the like, an IC of an Si substrate, an IC of a GaAs substrate, a resistor, a capacitor or the like. For ~~the~~ an electronic component 103 being, e.g., ~~the~~ an LED, an orientation of the LED is controlled by a mounting machine having a recognition function, so that the LED is stored in ~~the~~ a component storage part 102 with a light-emitting part of the LED directed ~~down~~ downwardly in the drawing. Although the electronic components 103 are placed ~~to~~ in all of the component storage parts 102 in Fig. 2, the present embodiment is not limited to this arrangement and the electronic component(s) 103 is sometimes placed ~~to~~ in only ~~part~~ some of the component storage parts 102 in relation to a circuit design.

[0033] When the electronic component 103 is a light- emitting element such as an LED or

the like, the component storage part 102 may be formed to have a side wall 1012 for shielding light of the light-emitting element. The side wall 1012 can prevent, for example, interference due to light emitted from an adjoining LED from arising.

[0034] In a succeeding step ~~3~~ S3, as shown in Fig. 3, an insulating adhesive 104 is filled and then cured in ~~the~~ each component storage part 102 with ~~the~~ an electronic component 103 stored therein. An adhesive of a type cured with ultraviolet rays, a thermosetting type adhesive or the like can be used as an example of the insulating adhesive 104. When ~~the~~ an adhesive to be cured with ultraviolet rays is used, for instance, the adhesive is cured by applying ultraviolet rays after the adhesive is filled into the component storage parts.

[0035] In a next step ~~4~~ S4, gold bumps 106 are formed correspondingly to ~~the~~ electronic components 103 ~~to~~ on a second board 105 which is to be electrically connected to the electronic components 103. In a next step ~~5~~ S5, it is decided whether or not leading end parts of the gold bumps 106 of the second board 105 are to be flattened. When ~~the~~ flattening is determined to be necessary, the ~~step goes~~ method proceeds to a next step ~~6~~ S6 and the flattening is carried out. Then the ~~step moves~~ method proceeds to a next step ~~7~~ S7. On the other hand, when ~~the~~ flattening is determined to be unnecessary, the ~~step~~ method skips step S6 and proceeds to ~~the~~ step ~~7~~ S7. Whether ~~the~~ flattening is necessary or not may be judged by a worker.

[0036] ~~In the~~ During step ~~7~~ S7 as shown in Fig. 4, a conductive adhesive 107 is applied to ~~the~~ leading end parts of the gold bumps 106 ~~of~~ on the second board 105. The second board 105 may be a semiconductor chip of, e.g., Si, GaAs, InP or the like. ~~In the~~ During step ~~7~~ S7, the first board 101 with the electronic components 103 and the second board 105 with the gold bumps 106 are aligned so as to ~~make~~ cause the electronic components 103 and the gold bumps 106 ~~meet~~ to contact each other, as indicated in Fig. 5. Then the first board 101 and the second board 105 are fitted to each other. After ~~the~~ this fitting, the conductive adhesive 107 is cured, thereby joining the first board 101 ~~and~~ to the second board 105. A first integral type electronic component 110 is formed in this manner.

[0037] According to the present embodiment, further ~~in~~ during a step ~~8~~ S8, a third board 108 is joined with a conductive adhesive 109 to the above-joined first board 101 and second board 105.

A second integral type electronic component 111 may be accordingly formed ~~accordingly~~ as shown in Fig. 6.

[0038] The assembling method for the integral type electronic component, and the integral type electronic component assembled by the method can exert the following effects. It has conventionally been ~~the~~ a problem ~~in the circumstances~~ as to how, without the first board 101, ~~how to~~ assemble small components while fixedly transferring the components. That is, a process related to ~~the~~ arranging and fixing ~~the~~ components has been complicated in the conventional art, thereby raising problems of a yield decrease, ~~etc.~~ and the like. In contrast to this, according to the present embodiment, an arrangement accuracy of electronic components 103 is determined on ~~the~~ a basis of an arrangement accuracy of component storage parts 102 formed ~~to~~ in the first board 101. Moreover, the electronic components 103 stored in the component storage parts 102 are limited in motion. In order to arrange the electronic components 103, it is ~~enough~~ sufficient only to insert the electronic components 103 ~~to~~ into the component storage parts 102. ~~The arrangement~~ Arrangement is thus made simple. ~~It won't take a long time before an end of the mounting~~ Mounting will be completed in a shorter time as compared with the conventional art even if there is a large number of electronic components 103 to be mounted. ~~The manufacturing~~ Manufacturing time is shortened and costs can be reduced in comparison with the conventional art.

[0039] ~~The arrangement~~ Arrangement of the electronic components 103 is realized highly accurately and simply at low costs in comparison with the conventional art.

[0040] Additionally, ~~the~~ an open fault is prevented because the bumps 106 ~~of~~ on the second board 105 are flattened.

[0041] Although the present invention has been fully described in connection with the preferred embodiment thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

ABSTRACT OF THE DISCLOSURE

An integral type electronic ~~component~~ device is formed ~~of~~ from a first board and a second board by storing and holding electronic components ~~to~~ in component storage parts of the first board, and then electrically connecting the second board to the electronic components. An arrangement accuracy of the electronic components is determined on ~~the~~ a basis of an arrangement accuracy of the component storage parts, and the electronic components stored and held in the component storage parts are limited in motion. ~~The electronic components can be arranged highly accurately and simply at low costs in a short time in comparison with the conventional art by being simply inserted to the component storage parts.~~